

Normal pregnancy

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اهداء الى

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للذين يتركون بنا اشياء سعيدة يجعلنا نبتسم دائمًا

Fertilization

- **Definition:**

- Fusion of mature sperm head (male gamete) with mature ovum (female gamete) to form zygote (fertilized egg).

- **Site:** ampulla of the fallopian tube.

- **Time:** within 12-24 hours of ovulation.

- **Steps of fertilization: SMPA**

1. At time of sexual intercourse, millions of **sperms** are deposited in vagina, some of these sperms travel in cervix & uterus to reach fallopian tube within 30 minutes.

2. Factors helping the **motility** of the sperms

- Forward progressive motility of the **sperms**
- Profuse & thin **cervical mucus** induced by estrogenic effect
- **Uterine** contractility induced by prostaglandins from semen
- **Tubal** peristalsis & ciliary movement.



3. The sperm must undergo two **processes** to be capable of fertilization:

- a- Capacitation :*

- Ability of sperm to reach & penetrate ovum, it occurs within 2-6 hours (cervical, uterine & tubal secretions are responsible for capacitation).

- b- Acrosomal reaction:*

- Removal of acrosomal membrane over sperm head with activation & release of proteolytic enzymes (which necessary for penetration of corona radiata of ovum)

4. After penetration of corona radiata, sperm **Attaches** to receptors on zona pellucida (species specific) thus enables head of mature sperm to penetrate zona pellucida.

5. Polyspermy is prevented by:

- Zonal reaction: change in the action potential of zona pellucida

- Cortical reaction: release of cortical granules in the perivitelline space.

6. Sperm penetration into ovum initiates 2nd meiotic division of oocyte with extrusion of 2nd polar body & reduction of its chromosomes from 46 to 23 (formation of female gamete)

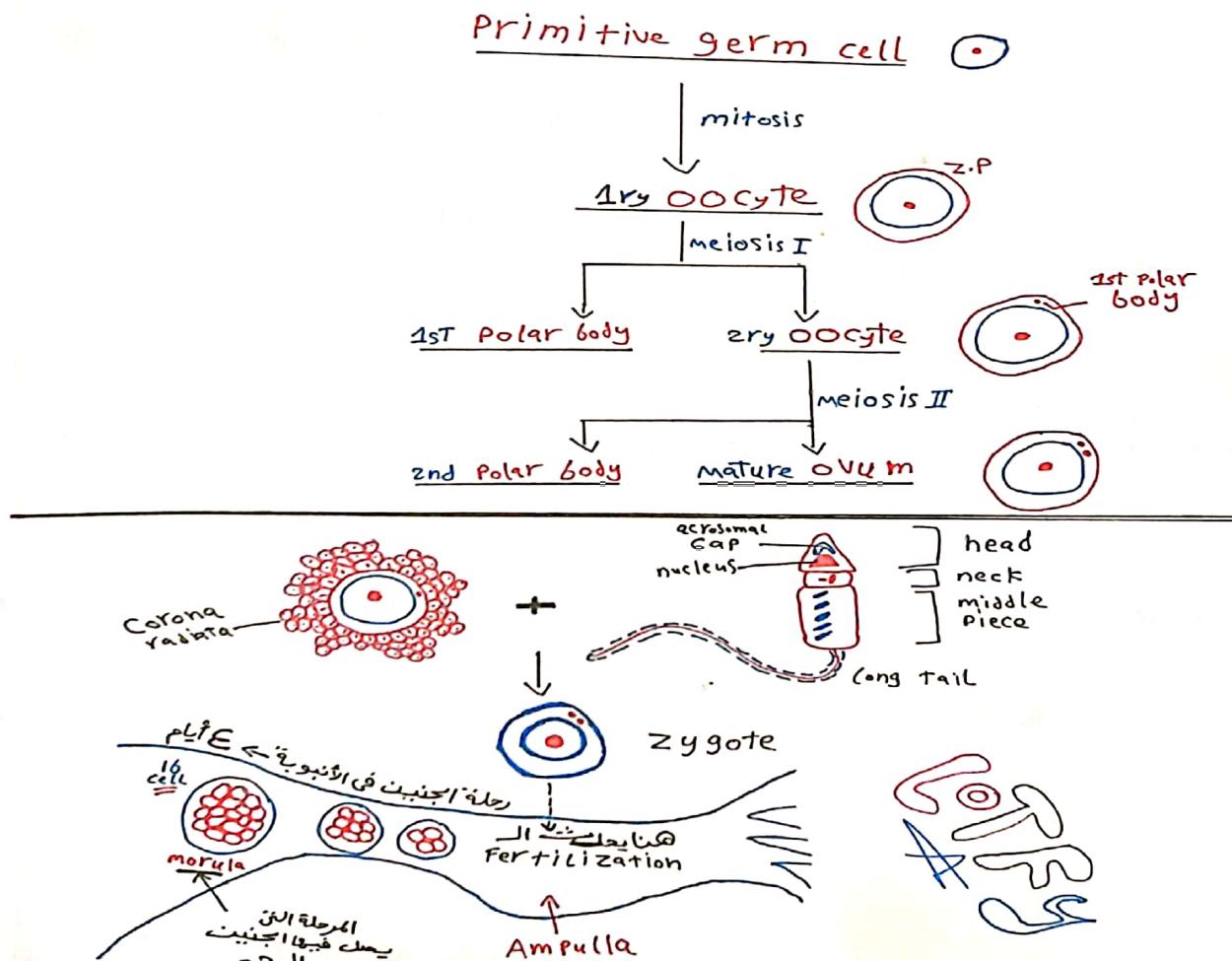
7. Fusion of both male & female gametes resulting in single zygote (46 chromosomes).

Zygote transport & division

- zygote (one cell stage) divide repeatedly to form round mass of cells called morula (16-cell stage)
- fertilized ovum reaches uterus 4 d after fertilization & remains in uterine cavity for 3 d where it reaches blastocyst stage (stage of implantation) so, fertilization-implantation interval is 1 w
- Travels towards uterine cavity is helped by: tubal peristalsis & ciliary movement
- During travel, fertilized ovum gets nutrition from fluid secreted by glandular cells of fallopian tube.

Implantation

- **Definition:** Embedding of blastocyst in the decidua.
- **Site:** Decidua of the upper uterine segment (60 % posteriorly & 40 % anteriorly)
- **Time:** Usually 7 days after fertilization.
- **Mechanism:** when blastocyst hatches out from ZP, trophoblast secretes an enzyme that erodes endometrial lining to create an implantation site
- **Stages:** (apposition - Adhesion - Penetration)



The Decidua

- **Definition:** Endometrium of pregnancy after fertilization (thickened & vascular).
- **Structure:** Exaggerated secretory changes in endometrium (tortuous glands containing secretion with edematous stroma).
- **Layers:**
 - **compact layer:** superficial layer contain opening of glands (compact to keep opening patent)
 - **spongy layer:** intermediate layer containing dilated portion of glands (plane of cleavage in placental separation).
 - **basal layer:** deep layer containing base of endometrial glands
- **Parts:**
 - **Decidua basalis:** lies deep to ovum between it & myometrium, it shares in placenta formation
 - **Decidua capsularis:** lies superficial to the ovum, separating it from the uterine cavity.
 - **Decidua parietalis (lateralis or vera):** part of decidua lining rest of the uterine cavity
 - ✓ **NB:** As ovum enlarges & fills the uterine cavity, the decidua capsularis fuses with the decidua parietalis thus obliterating the decidual space. This occurs at the 12th week of pregnancy .
- **Function of decidua:**
 1. Site of implantation of fertilized ovum.
 2. **Protection** of the uterine wall against invasion by the chorionic villi.
 3. **Protection** of the embryo against rejection.
 4. **Nutrition** of embryo in early stage of development as its cells contain fat & glycogen
 5. Formation of the placenta.

Development of chorionic villi

- At the blastocyst stage, embryo is surrounded by trophoblast (chorion) which differentiated into:
 1. **inner cytotrophoblast (Langhan's cells)**
 2. **Outer syncytiotrophoblast**
- trophoblastic tissue (chorionic tissue) penetrates decidua & erodes decidual blood vessels leading to formation of free spaces called **chorio - decidual spaces**.
- Further development of the chorionic tissue in these spaces forms chorionic villi.
- There are three stages of formation of chorionic villi:
 1. **1ry villi:** (syncytiotrophoblast & cytotrophoblast.)
 2. **2ry villi:** (1ry villi + mesoderm.)
 3. **3ry villi :** (2ry villi + fetal blood vessels.)

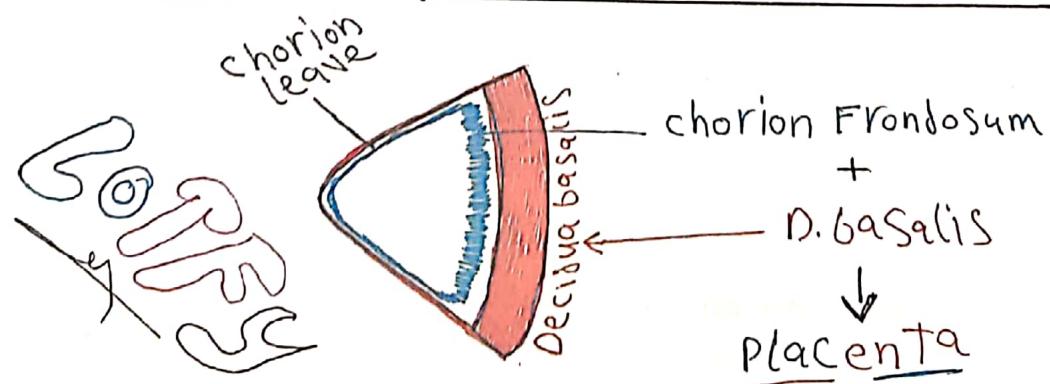
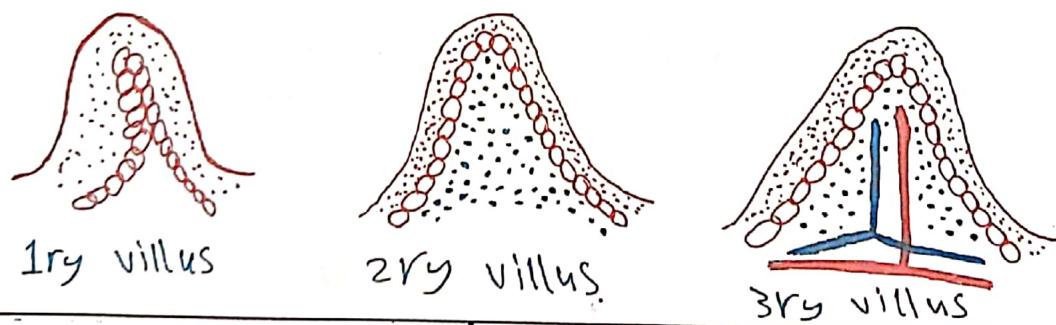
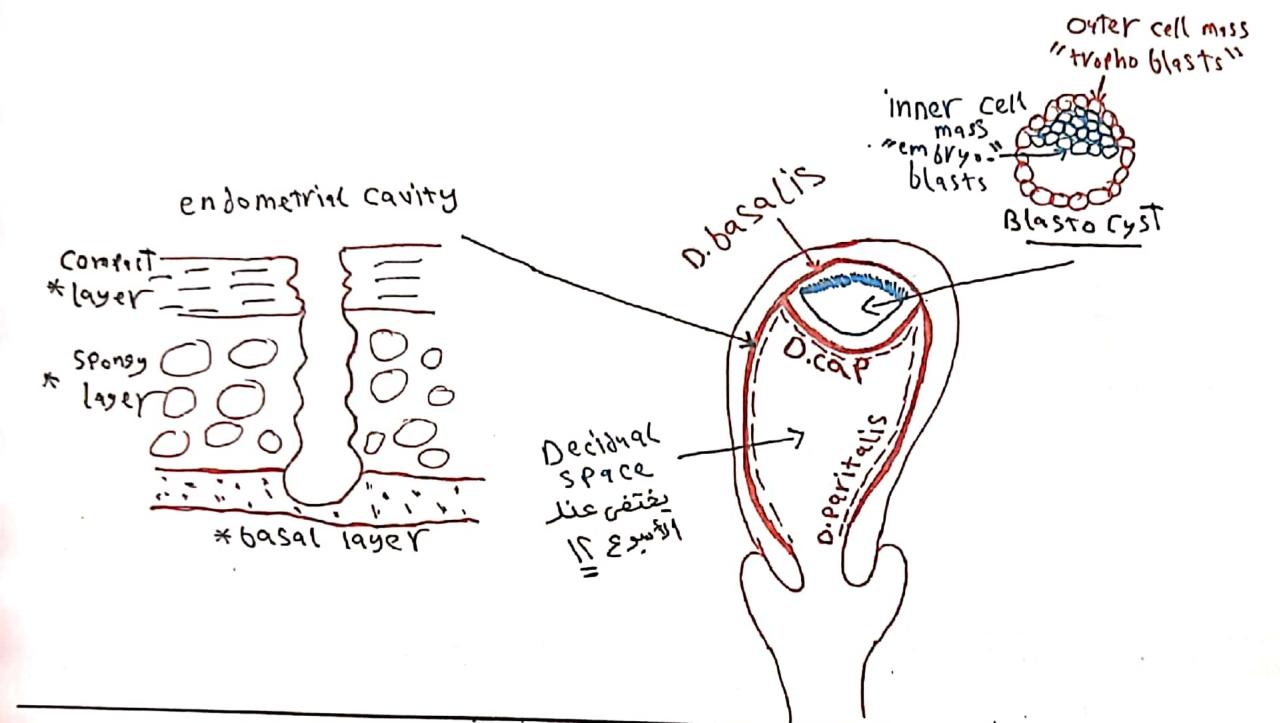
- At the 12th week :

- the villi related to the decidua capsularis disappear forming **chorion laeve**
- The villi related to the decidua basalis grow & form **the chorion frondosum**, which will share in the formation the placenta.

- Functions of chorionic villi:

1. Nutrition
2. Support
3. Secretion of placental hormones

✓ **NB:** Nitabuch layer is zone of fibrinoid degeneration between decidua basalis & trophoblastic layer



The placenta

- **Embryology (Origin):**

- **Maternal part:** From decidua basalis
- **Fetal part:** From chorion frondosum

- **Anatomy at term:**

- **Shape:** Discoid
- **Color:** Dark red
- **Diameter:** 15-20 cm.
- **Weight:** 500 gm.
- **Thickness:** 2 inches at the center, thinner in the periphery
- **Position:** In upper uterine segment (99.5%) posterior (60%) anterior (40%).
- **Surfaces:**

Fetal surface	maternal surface
▪ Smooth, glistening	▪ Rough, non-glistening
▪ covered by amnion	▪ covered by decidua basalis
▪ Amnion can be peeled off from underlying chorion except at insertion of cord	
▪ Umbilical cord is attached to it (at or near center)	▪ Numerous small greyish spots may be visible on it representing calcium deposition in degenerated areas.
▪ Branches of umbilical blood vessels are visible beneath amnion as they radiate from the insertion of the cord.	▪ It is divided into (15-20) cotyledons, ▪ Each cotyledon may be supplied by its own spiral artery.

- **Histology: (blood placental barrier)**

- **Layers:** **SCME**

- **S**yncytiotrophoblast
- **C**ytotrophoblast
- **M**esoderm of the villi
- **E**ndothelial lining of the fetal blood vessels

- **After 20 w** cytotrophoblast & mesoderm disappear & barrier is formed only of 2 layer
- **After 24 weeks**, progressive thinning of the barrier occurs.

• Functions of the placenta NHR BES

1. **Nutritive function:** For transfer of

- water (by simple diffusion)
- glucose (by facilitated diffusion)
- Amino acids, calcium & iron (active transport)
- Vitamins ... etc.



2. **Hematological function:** producing fetal hemoglobin

3. **Respiratory function (main function) :** exchange of gases between maternal & fetal blood. Fetal Hb (HbF) has a higher affinity to oxygen than adult Hb.

4. **Barrier action :** selectively allows passage of some substances according to their molecular weight & charge e.g.:

❖ **Drugs**

- a. Not pass Heparin, Insulin & thyroxine.
- b. Pass Penicillin (beneficial), Thalidomide (phocomelia).

❖ **Anti-bodies:** IgG can pass but IgM can't pass.

❖ **Organisms:** STORCH can pass.

5. **Excretory function:** placenta acting as a fetal kidney

6. **Endocrinological functions of the Placenta** شرحها

7. **Secretory function :**

❖ **Enzymes** e.g HIMO

- Heat stable alkaline phosphatase
- Insulinase
- MAO
- Oxytocinase

❖ **Proteins & hormones**

 **Endocrinological functions of the Placenta** Syncytiotrophoblast secretes:

1. Human chorionic gonadotropin (HCG)
2. Human placental lactogen (HPL),
3. Estrogen
4. Progesterone

✓ **N.B** Decidua & fetal membranes secretes:

- Relaxin : cause uterine relaxation
- Prolactin

1-Estrogen Mainly (90%) Estriol (E3)	2-Progesterone:
↑ Size & vascularity of genital tract.	Prepares the decidua
↑ Sensitivity & expression of myometrial oxytocin receptors.	↑ smooth muscle relaxation of uterus, ureter & GIT
↑ Growth of nipple & duct system of breast.	↑ development of alveolar system of breast
↑ Water retention & protein synthesis.	↑ body temp

3. Human placental lactogen (HPL):

- Has a structure & function similar to growth hormone,
- Functions:
 1. Gross promoting effect on fetus (Somatotrophic) by anti-insulin & lipolytic effects
 2. Lactogenic
 3. Erythropoietic effect

4. Human chorionic gonadotropin:

- Structure:
 - Glycoprotein, protein part composed of one alpha subunit similar to that of FSH, LH & TSH & One beta subunit specific to HCG
- Levels:
 - Secretion starts **1 day** after implantation
 - level is **100 IU/L** on the day of the first missed period
 - It **doubles every 2-3 days**
 - It reaches **1500 IU/L** at **5 weeks** gestation. This level is considered **the discriminatory zone of TVS** as TVS must identify any intrauterine pregnancy when hCG level is above this zone.
 - It reaches **6000-6500 IU/L** at **6 weeks** gestation. This level is considered **the discriminatory zone of TAS** as TAS must identify any intrauterine pregnancy when level of hCG is above this zone.
 - It reaches **peak of 100,000 IU/L** at **10-12 w**, & plateaus during the rest of pregnancy.
- Functions:
 1. Maintenance of corpus luteum until development of the placenta.
 2. Suppress maternal immunological reaction against fetus.
 3. Stimulates testosterone production in male fetus.
 4. Adrenocorticotropic effect on fetus
- Clinical uses:
 - **Diagnostic:**
 1. Diagnosis of normal pregnancy
 2. Diagnosis & follow up of ectopic pregnancy
 3. Diagnosis & follow up (used as a tumor marker) of gestational trophoblastic disease
 - **Therapeutic:**
 1. Ovulation induction
 2. Luteal phase support

- **Abnormalities & diseases of placenta**

- Abnormalities In the site of implantation:

- In lower uterine segment (placenta previa)
- In tube, cervix, peritoneum & ovary (ectopic pregnancy)

- Abnormalities in the size of the placenta:

- ↑ size (Placentomegaly) : DM, Multiple pregnancy & Rh isoimmunization
- ↓ size: Severe pre-eclampsia, heart disease, IUGR

- Abnormalities in the shape of the placenta : 2Bi CAS FM

1. **Bilobate or multilobate placenta:** two or more equal lobes attached by placental tissue. It can cause retained placenta, postpartum hemorrhage & puerperal sepsis

2. **Bi-partite or multipartite placenta:** two or more equal lobes attached by a membrane. It can cause vasa previa, retained placenta, postpartum hemorrhage & puerperal sepsis

3. **Circumvallate placenta:** Thick whitish ring around the edge of placental fetal surface. It can cause abortion, preterm labour, IUGR, IUFD, placental abruption & associated with ↑ risk of congenital fetal malformation

4. **Annular Placenta:** empty center

5. **Placenta Succenturiata:** two unequal lobes attached by placental tissue or membrane. It can cause vasa Previa, retained placenta, postpartum hemorrhage & puerperal sepsis

6. **Fenestrated placenta:** empty eccentrically

7. **Placenta Membranecea:** Thin & large placenta. may reach LUS → placenta previa

- Abnormal attachment of the cord:

- **Marginal insertion:** Battledore placenta.
- **Velamentous (membranous):** Cord is inserted into membranes. It can cause vasa Previa if associated with placenta Previa

- Abnormal adhesions:

- The decidua basalis is absent or poorly formed (absent Nitabuch layer), it may be :
 - **Simple adhesion:** The villi invades deep decidua basalis.
 - **Morbid adhesion:**

- a- **Placenta accreta :** Invasion of superficial layer of myometrium,
- b- **Placenta increta :** Invasion deep inside the myometrium,
- c- **Placenta percreta :** Invasion of perimetrium.

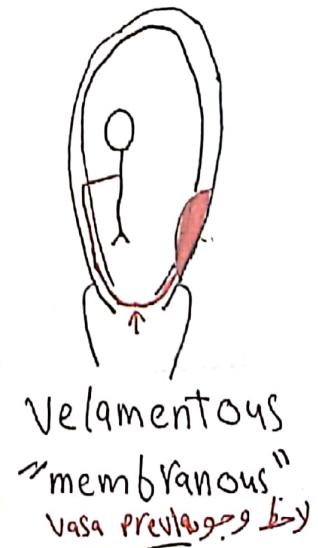
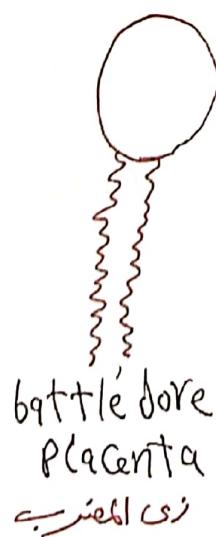
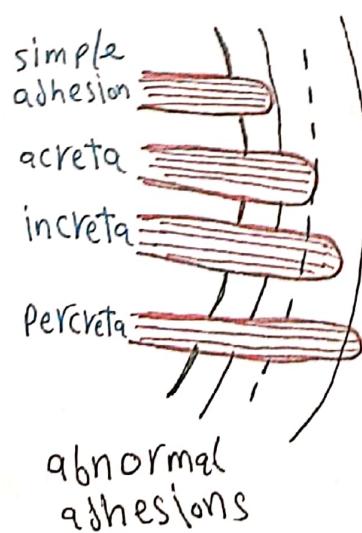
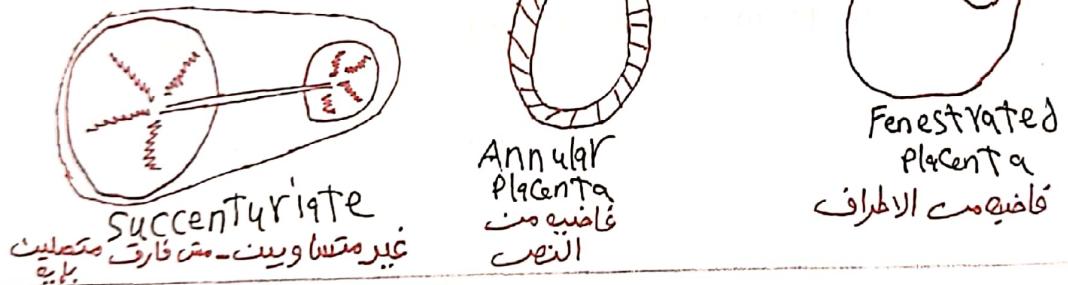
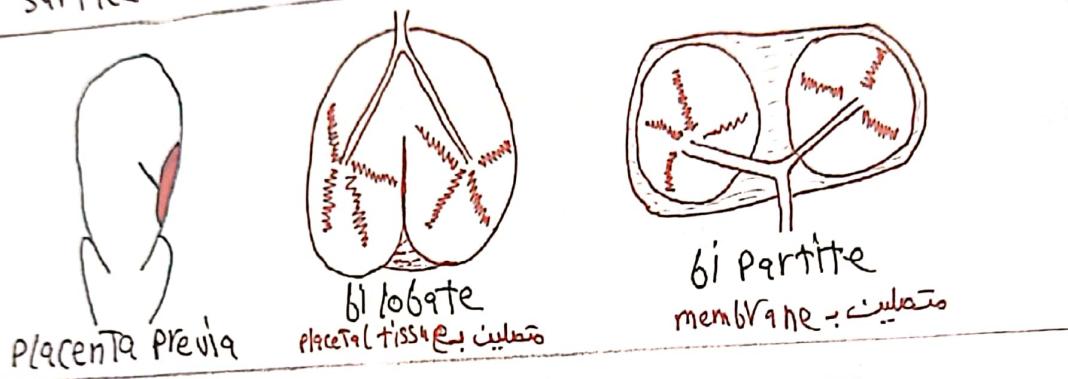
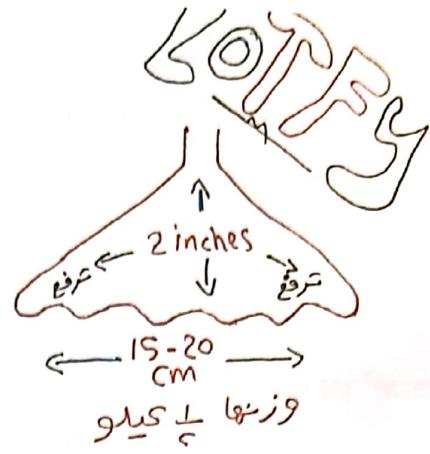
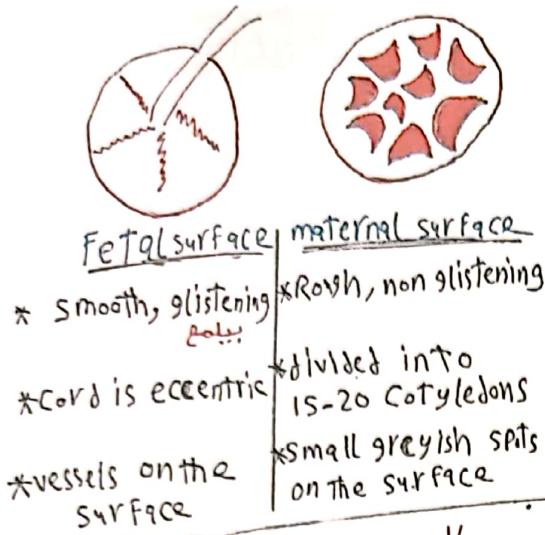
- ✓ The condition leads to retained placenta.

- **Traumatic:** retro-placental hematoma

- **Inflammatory:** infection e.g. Syphilis, TB.

- **Neoplastic:** Placental neoplasms: GTD or 2ry neoplasm (e.g. melanoma)

Site – size – shape
Adhesions – attachments
Traumatic – inf - neoplastic



The Umbilical cord (Funis)

- **Embryology (Origin):** Mesoderm connecting inner cell mass with chorion
- **Anatomy at term:**
 - **Length:** 50 cm (30-70 cm)
 - **Diameter:** 2cm
 - **Shape:** Thick, soft & tortuous
 - **Insertion:** The cord is inserted in the fetal surface of the placenta near the center "eccentric insertion" about 70% or at the center "central insertion" about 30%.
- **Histology:**
 - **Covering amnion**
 - **Wharton's jelly:** connective tissue around blood vessels
 - **Blood vessels:**
 - 1 umbilical vein (carrying **oxygenated blood** to the fetus)
 - 2 umbilical arteries (carrying **non-oxygenated blood** from the fetus)
- **Anomalies & diseases of umbilical cord:**
 - ❖ **Abnormal in length:**
 - **Short cord < 30 cm:**
 - May cause avulsion of cord, placental abruption or prolongation of 2nd stage of labor
 - **Long cord > 70 cm:**
 - May cause cord prolapse or true knots.
 - ❖ **Abnormal attachment into placenta:**
 - **Marginal insertion:** Battledore placenta.
 - **Velamentous (membranous):** Cord is inserted into membranes.
 - It can cause vasa previa if associated with placenta previa
 - ❖ **Abnormal number of blood vessels**
 - One umbilical artery (may be normal variant in 1 %)
 - ❖ **Knots:**
 - **True:** When fetus passes through a loop of a long cord. It may lead to IUGR or IUFD.
 - **False:** Localized collection of Wharton's Jelly or aneurysmal dilatation of blood vessels.
 - ❖ **Congenital** umbilical hernia: exomohalos
 - ❖ **Traumatic** (Hematoma): due to rupture of one of the umbilical vessels
 - ❖ **Inflammatory:** Funitis
 - ❖ **Neoplastic:** cysts, myxoma, hemangioma & melanoma

The Fetal Membranes

- Amnion: transparent membrane, lines chorion. It covers fetal surface of placenta & umbilical cord.
- Chorion: Is the outer membrane. It is in contact with the uterine wall

The Amniotic Fluid (The Liquor Amnii)

- **Characters:**

1. **Physical properties :**

- It is colorless fluid.
- Specific gravity: 1010 -1020.
- Reaction: neutral or slightly alkaline.
- Volume ↑ throughout pregnancy from 50 ml at 12 weeks to reaches its maximum volume at 36 weeks about 1 litre & ↓ thereafter.

2. **Chemical composition :**

- Water: 98-99%.
- Solids: 1-2%, organic & inorganic.
 - Organic constituents include carb (as glucose & fructose) , proteins & hormones
 - Inorganic constituents are similar to those found in maternal plasma as Na & Cl, also hair & vernix caseosa are present.

- **Origin:**

- The amniotic fluid has both fetal & maternal origin.
 - Before 20 weeks: by diffusion from maternal plasma through amniotic membrane.
 - After 20 weeks: in addition to diffusion, fetal urination forms major source (500ml/day) plus other fetal secretions e.g. lung, saliva.

- **Fate:**

- 1- **Fetal**: Swallowing.
- 2- **Maternal**: Transudation into maternal circulation.

- **Functions:**

A. During Pregnancy:

1. Protection of the fetus against external trauma.
2. Prevents ascent of infection, from the cervix or vagina.
3. prevents adhesions between the amnion & fetal skin
4. It keeps the fetal temperature constant.
5. It allows free fetal movements helping the development of fetal muscles.
6. Acts as a medium for fetal excretion

B. During Labour:

1. bag of forewaters helps dilatation of the cervix.
2. It prevents direct compression of the placenta & umbilical cord between the uterine wall & fetus during uterine contraction thus avoiding fetal asphyxia.
3. When membranes rupture, fluid washes birth canal from above downwards thus removing away any infectious material.

➤ Disorders of amniotic fluid → see later

Placental circulation

♣ the placental circulation consists of two different systems:

1. Uteroplacental circulation:

- Uteroplacental circulation is the maternal blood circulating through the intervillous space.
- Intervillous blood flow at term is estimated to be 500-600mL/min, & blood in intervillous space is replaced 3-4 times per minute.
- Pressure & concentration gradients between fetal capillaries & intervillous space favors placental transfer of oxygen & other nutrients to the fetus.

2. Feta-placental circulation:

- Two umbilical arteries carry deoxygenated blood from the fetus to placenta .
- Arteries divide into small branches & enter chorionic villi, where further division to arterioles & capillaries occurs.
- The blood then flows to corresponding venous channel & subsequently to umbilical vein.
- Maternal & fetal blood flow side by side, in opposite directions, facilitating exchange
- The fetal blood is adapted to carry more oxygen by the following:
 - Fetal hemoglobin (HbF) concentration is 50% higher than maternal hemoglobin.
 - Fetal Hb has higher affinity for oxygen & carries more oxygen (20- 30%) than maternal

Fetal Circulation

The fetal circulation differs from the adult one by the presence of three major vascular shunts:

1. Ductus venosus : between the umbilical vein & inferior vena cava.
2. Foramen ovale : between the right & left atrium.
3. Ductus arteriosus : between the pulmonary artery & descending aorta

❖ The circulation is as follows:

1. The umbilical vein carries oxygenated blood from the placenta to the fetus.

2. As it enters the fetal body:

- a) Most of its oxygenated blood passes to (IVC) through **ductus venosus**.
- b) remainder passes to **portal vein** to supply liver. Liver drains into IVC through **hepatic veins**.

3. The blood in the IVC:

- a) Most of it directed to **left atrium** through **foramen ovale** then to **Lt ventricle & descending Aorta**
- b) remainder of blood in **right atrium** passes with that coming from head & upper limbs via **superior vena cava** to **right ventricle** → **pulmonary artery** where most of it passes also to **aorta** through **ductus arteriosus** because of high resistance of the unexpanded fetal lungs.

4. blood passes from aorta to internal iliac arteries (hypogastric) → umbilical arteries → placenta

❖ Changes in fetal circulation after birth:1. **Ductus venosus → ligamentum venosum**

- The pressure in the **ductus venosus** drops with clamping of the **umbilical cord** leading to its closure to form → **ligamentum venosum**

2. **Foramen ovale → fossa ovale**

- The initiation of respiration creates -ve intra-thoracic pressure which is transmitted to **right ventricle** and **atrium**, while the pressure in the **left atrium** is ↑ due to returning blood from the **lungs** this leads to closure of the **foramen ovale** leaving a remnant called **fossa ovale**.

3. **Ductus arteriosus → ligamentum arteriosum**

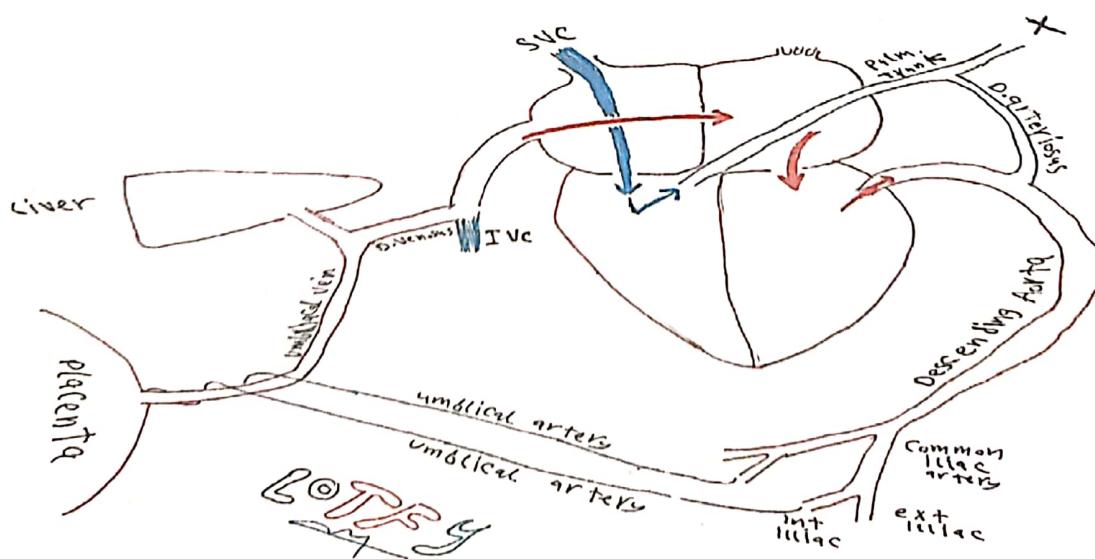
- Because of diversion of most of the blood into the **lungs**, no further blood passes through the **ductus arteriosus** leaving a remnant called **ligamentum arteriosum**

4. **Umbilical vein → ligamentum teres** in the falciform ligament of the liver.

- umbilical vein is obliterated to form **ligamentum teres** in falciform ligament of the liver.

5. **Hypogastric arteries → hypogastric ligament**

- hypogastric arteries are obliterated to form the **hypogastric ligaments**



Maternal physiological changes during pregnancy

1- The genital system

1. UTERUS:

- Anatomical changes:

1. ↑ size & weight:

- Length: ↑ from 7.5 cm in the pre-pregnant state to 35 cm at term.
- Uterine cavity expands from 4 ml to 4 L but can reach up to 20 L in as in polyhydramnios.
- Weight: from 50-70 gm to 1 kg at full term.
- ↑ Size & weight due to muscle hypertrophy up to 20 W, after which stretching of muscle fibers occurs.

2. Level: (site)

- < 12 weeks:	Uterus is pelvic organ
- > 12 weeks:	Uterus is pelvi - abdominal organ
▪ At 12 weeks:	at level of symphysis pubis
▪ At 24th weeks:	at level of umbilicus
▪ At 36th weeks:	at level of xiphisternum

3. Shape:

- non-pregnant uterus	Pear (pyriform) shaped.
- At 8th week	globular with the size of an orange
- At 16th week	becomes pyriform again & remains as such till term

4. Position:

- In 80% uterus dextroflexed (deviated to Rt) & dextrorotated (twisted on itself from Lt to Rt)
- Dextrorotation is caused by presence of sigmoid colon on left side of pelvis & brings left round ligament nearer to midline.

5. Consistency:

- uterus show progressive softening due to:
 - ↑ vascularity
 - presence of amniotic fluid

6. ↑ vascularity:

- uterine & ovarian arteries undergo massive hypertrophy
- Uterine blood flow ↑ from 75 ml/min to 500-700 mL/min at term.

- **Histological changes:**

- **Endometrium:** Decidua
- **Myometrium:** Hypertrophy & hyperplasia & increased elastic fibers
- **Uterine ligaments:** Hypertrophy

- **Physiological changes:**

1. **Braxton Hick's contractions:**

- Irregular, non-rhythmic & sporadic contractions
- Their intensity varies between 5 & 25 mm Hg
- They help placental circulation early in pregnancy
- These contractions detected by bimanual examination in first trimester (**Palmer sign**) & by abdominal examination in the 2nd trimester.
- Although usually painless, they may cause discomfort in last weeks of pregnancy & called false labor pains

2. **Lower uterine segment formation:**

- After 12 w, isthmus (0.5cm) starts to expand gradually to form LUS (10 cm) at term

 **Clinical importance:**

1. It is the site of lower segment cesarean section (LSCS)
2. If the placenta is implanted on it: placenta previa (PP)
3. Obstructed labour: pathological retraction ring between upper & lower segments

Comparison between upper & lower uterine segments

	Upper uterine segment	Lower uterine segment
Peritoneum	Adherent	Loose
Muscle layers	3 layer (inner circular, middle oblique (figure of 8) & outer longitudinal)	2 layers (inner circular, outer longitudinal)
Membranes	Firmly attached	Loosely attached
During labour	More active Contracts & retracts Becomes thicker & shorter	Less active Relaxes & stretches Becomes thinner & longer

Spotlight In Obstetrics

2-Cervix	3- vagina	4- ovary
- Hypertrophy & softening (Goodell's sign)	- Hypertrophy & softening	- Hypertrophy & softening
- ↑ vascularity	- ↑ vascularity: vulval Varicose veins	- ↑ vascularity
- Blue or violet discoloration (Chadwick's sign)	- Blue or violet discoloration (Chadwick's sign)	- Inhibition of ovulation
- ↓ cervical collagen towards term to enable its dilatation	- ↑ estrogen + glycogen deposition, action of lactobacilli on glycogen in vaginal cells produces lactic acid that ↓ pH to keep vagina relatively free from any pathogens	- Corpus luteum degenerates at 10th week, but pregnancy luteoma may occur
- Cervical mucus plug: closes cx & discharged as bloody show with onset of labor		

2- The breast

- ↑ Size & softening.
- **Nipples & areola**
 - Nipple become more prominent, erectile & sensitive.
 - Nipple & 1st areola become darker (on 2nd month).
 - Montgomery's tubercles (hypertrophied sebaceous glands) appears from 2nd month
 - 2nd areola: less pigmented area around 1st areola appear with start of 2nd trimester.
- **Colostrum** (thick, protein-rich fluid) can be expressed by end of 3rd month.
- **Milk**: Prolactin stimulates cells of alveoli to secrete milk, but its effect is blocked during pregnancy by peripheral action of estrogen & progesterone.

3- The Cardiovascular system

• Blood volume	- ↑ 40-50% (maximum by 32 weeks).
• Resting heart rate	- ↑ by 10-15 bpm
• Arterial blood pressure	- ↓ Especially during the second trimester & rises thereafter.
• Stroke volume	- ↑ Due heart hypertrophy, ↑ blood volume & ↓ peripheral resistance.
• Cardiac output	- ↑ due to ↑ stroke volume & heart rate
• (COP=HR X SV)	- Rapidly ↑ in 1 st trimester by 40% & steadies for rest preg. - Maximum ↑ in COP & blood volume occurs during labor

Spotlight In Obstetrics

• heart

- enlarged, displaced upward
- Functional systolic murmur is heard over the heart.

- ❖ Supine hypotension syndrome; occur in late pregnancy in 10% of pregnant women,
 - in supine position gravid uterus compresses in I.V.C. → ↓ venous return → ↓ COP → ↓ BP. So, pregnant is advised to lie on her side (LT)

4-Hematological changes

- Plasma volume & red cell volume increase during pregnancy.
- This begins at 8-10 weeks' gestation & reaches peak levels at 32 weeks.
- **RBCs**
 - ↑ in plasma volume (50%) > rise in RBCs (25%).
 - result is ↓ hemoglobin (Hb) & hematocrit (Hct) levels. Known as physiological anemia of pregnancy (haemodilution).
- **WBCs**: ↑ up to 16000
- **Platelets**: Gestational thrombocytopenia
- **Albumin**: Dilutional hypoalbuminemia

5-The respiratory system

• Anatomical changes:

1. **Subcostal angle**: widens.
2. **Diaphragm**: rises by 4 Cm.
3. **Transvers diameter of thorax**: increased 2 Cm.

• Physiological changes

1. **Residual-volume**: ↓ by 15 to 20 % due to elevation of diaphragm.
2. **Hyperventilation**:
 - ↑ PO₂ & ↓ PCO₂
 - ↑ arterial pH slightly to 7.44 (Mild respiratory alkalosis)
3. **Dyspnea** is common in late pregnancy due to:
 - Hyperventilation (progesterone effect)
 - Elevation of the diaphragm (especially during the 8th month)

6-GIT

1. **Emesis gravidarum (Morning sickness)**: nausea & sometimes vomiting especially in morning not affect general condition of pregnant female.
2. **Epulis**: gum hypertrophy & edema

3. **Pica:** where patient desires or refuses certain foods or odors.
4. **Ptyalism:** due to difficulty in swallowing
5. **Reflux esophagitis (heart burn, pyrosis)** : due to regurgitation of stomach contents into esophagus caused by hypotonia of cardiac sphincter (P relaxing effect) & ↑ abdominal pressure.
6. **Dyspepsia, indigestion & delayed gastric emptying** due to ↓ motility of stomach (progesterone & relaxin effect) & ↓ gastric secretions.
7. **Hypochlorhydria:** due to regurgitation of alkaline intestinal chyle into stomach → ↓ iron absorption → iron deficiency anemia.
8. **Constipation:** due to pressure of uterus on pelvic colon &
9. **Hemorrhoids:** due to constipation & high venous pressure (by uterine compression).
10. **Hypotonia of gall bladder:** increased susceptibility to gall stones.

7-The renal system

- **Anatomical Changes:**

- Kidney size ↑ by about 1 cm.
- Marked dilatation of calyces, renal pelvis, & ureter from 1ST trimester
- Urinary bladder relaxes & its capacity ↑.

- **Physiological changes:**

- **Renal blood flow (RBF) & glomerular filtration rate** ↑ by 40% in 1ST trimester
- **Creatinine clearance** ↑
- **serum creatinine & urea** ↓
- **Glycosuria & aminoaciduria** due to ↓ renal blood threshold
- **UTI** is more common due to ureteric dilatation stasis & ↓ immunity.
- **↑ frequency of micturition** due to:
 - Pelvic congestion & edema of mucosa of bladder & urethra
 - Pressure on bladder by gravid uterus or head late in pregnancy
 - ↑ GFR which ↑ urine output

9-The Endocrine system

Pituitary:	Thyroid	Parathyroid	Adrenals
<ul style="list-style-type: none"> ▪ Ant. pituitary ↑ in size & activity ▪ Post. pituitary produces oxytocin → stimulating onset of labor ▪ ↑ Plasma prolactin level (E effect) 	<ul style="list-style-type: none"> ▪ ↑ in size & activity ▪ Total T3 & T4 are ↑ but free unchanged ▪ Physiological goiter unlikely in absence of iodine deficiency 	<ul style="list-style-type: none"> ▪ ↑ size & activity to regulate increased ca^{+2} metabolism 	<ul style="list-style-type: none"> ▪ ↑ activity ▪ Total cortisol ↑ but free unchanged.

8-The immune system

- ↓ cell mediated & humoral immunity (immuno-suppressive state)
- interferon is absent in pregnancy
- WBCs ↑ (up to 16000).

10-The skin

- **↑ Pigmentation:** due to ↑ estrogen, melanocyte-stimulating hormone (MSH) & corticotrophin releasing hormone (CRH)
 - Linea Alba becomes linea nigra
 - Breast (1st areola, nipple, & 2nd areola)
 - Chloasma كلف الحمل (brown patches of pigmentation seen especially on the face)
- **Stria:** Variable incidence & Due to disruption of subcuticular collagen fibers by:
 1. ↑ adrenocortical hormones
 2. relatively rapid expansion of the abdominal skin
 - ❖ **Rubra (red):** stretching of skin & appearance of subcutaneous blood vessels.
 - ❖ **Albicans (white):** due to fibrosis in stria rubra
 - ❖ **Nigra (black):** due to stretching + melanocytic activity.
- **Itching & pruritis:** due to bilirubin & bile salts
- **Palmar erythema & spider naevi** are also common
- **Pruritic urticarial papules & plaques of pregnancy (PUPPP):** over trunk

11-Metabolic changes

- **Protein metabolism:**
 - Positive nitrogen balance
 - ↑ daily requirements for protein intake during pregnancy
- **Fat Metabolism:**
 - ↑ lipolysis → ↑ free fatty acids due to action of human placental lactogen
- **Carbohydrate Metabolism:**
 - Pregnancy is diabetogenic mostly during 3rd trimester due to insulin antagonism, by human placental lactogen, estrogen & progesterone of pregnancy & due to production of insulinase by the placenta cortisol.
 - Normal pregnancy is characterized by
 - o Mild fasting hypoglycemia
 - o postprandial hyperglycemia
 - o Hyperinsulinemia (β cells hyperplasia)

Diagnosis of pregnancy

- **Symptoms:**

- ❖ **Missed period:**

- Most obvious symptom is cessation of periods in a woman having regular menstruation.

- ❖ **Morning sickness (Emesis gravidarum):**

- Nausea & sometimes vomiting especially in morning not affect general condition of pregnant women,
- Occurs in about 50% of pregnant women (the most frequent complaint of early pregnancy)
- Usually appear at the 6th week & disappears after the 12th - 14th week

- ❖ **Pica**

- Patient desires or refuses certain foods or odors.
- Occasionally experienced by pregnant women.

- ❖ **Breast enlargement & sensation of heaviness**

- Often seen early in pregnancy, particularly in the first month

- ❖ **Abdominal enlargement** :As pregnancy advances

- ❖ **Frequency of micturition:** Due to

- Pelvic congestion
- edema of mucosa of bladder & urethra
- Pressure on bladder by gravid uterus or head late in pregnancy
- ↑ GFR that ↑ urine output
- ✓ not associated with dysuria, which may denote possible infection.

- ❖ **Fetal movements** : (quickening) (the first perception of fetal movement):

- 18-20 wks. Gestation in the nullipara
- 16-18 wks. In the multipara.

- ❖ **Easy fatigability & tendency to sleep**

- Common in early pregnancy
- Tends to disappear after 12wks gestation

- **Clinical examination:**

- ❖ **General**

- Breast signs of pregnancy
- Skin signs of pregnancy

- ❖ **Abdominal**

- **Uterine signs:**

- Palmar's signs : Braxton Hick's contraction felt on bimanual examination

- Before 12 weeks uterus is pelvic organ
- after 12 weeks uterus is palpable abdominally & at 24 weeks it is felt at level of umbilicus

- Regarding the fetus :

- **Inspection** : for fetal movements
- **Palpation** of fetal parts & movement at 20 weeks
- **Auscultation**:
 - Fetal heart sounds may be heard using a hand-held Doppler (sonicaid) at 10-12 weeks & at 20-24 weeks by the Pinard's stethoscope.
 - **Umbilical (funic) soufflé** : A murmur with the same rate of FHS due to rush of blood in the umbilical arteries) may be occasionally heard

Uterine soufflé	Umbilical soufflé
<ul style="list-style-type: none"> ▪ A murmur with the same rate of maternal heart sound ▪ Not sure sign of pregnancy 	<ul style="list-style-type: none"> ▪ A murmur with the same rate of FHS ▪ Not sure sign of pregnancy

❖ **Local** (Cervical & vaginal signs):

- Goodeli's sign: hypertrophy & softening of cx.
- Chadwick's sign: bluish discoloration of the vagina & cx

- **Investigations:**

❖ **Pregnancy Tests:**

1. Serum pregnancy tests:

- Detects serum (β -hCG)
- Can confirm pregnancy 5-7 days before the first missed period
 - ✓ Qualitative pregnancy test shows a positive result with serum β -hCG Levels >25 IU/L.
 - ✓ Quantitative pregnancy test: shows actual serum β -hCG levels.

2. Urine pregnancy tests:

- Detects (β -hCG) excreted in urine.
- Can confirm pregnancy 5-7 days after the first missed period
- Technique:

❖ Agglutination inhibition test:

- Add a drop of female morning urine + anti β -hCG serum & mix.
- Add standard B-HCG adsorbed on latex particles
- Results :
 - No agglutination \rightarrow **+ve** pregnancy test
 - Agglutination \rightarrow **-ve** pregnancy test

❖ Home kits:

- Add 3-4 drops to the kit & wait 3-4 min.
- Results:
 - If two lines appear **+ve** pregnancy test.
 - If only one line appears **-ve** pregnancy test.

❖ **US diagnosis of pregnancy:**- **Trans-vaginal sonography (TVS):**

- Gestational sac at 4th week
- Fetal pole at 5th week
- Fetal pulsation at 6th week.

- **Trans-abdominal sonography (TAS):** The same like (TVS) but later by 1 week.

• **Sure signs of pregnancy:**

- 1- **inspection** : Ultrasound or X-ray
- 2- **Palpation** of fetal parts
- 3- **Palpation** of fetal movements
- 4- **Auscultation** of fetal heart sounds
- 5- **Auscultation** of the umbilical (funic) soufflé

• **Differential Diagnosis:**

- 1- Pseudocyesis (False pregnancy)
- 2- Other causes of 2ry amenorrhea
- 3- Other causes of symmetrically enlarged uterus.

Antenatal care

- **Definition:**
 - program of preventive obstetrics to improve maternal & fetal outcome by regular monitoring of pregnancy

- **Objectives:**
 - Ensure best health for mother & fetus
 - Early detection & management of any problem (maternal or fetal)
 - Education of the mother about:
 - Physiology of pregnancy
 - Nutrition
 - Alarming symptoms
 - Infant care & Breast-feeding

- **Schedule of antenatal care visits:**

- For low-risk cases, the following schedule of visits should be followed:
 - Up to 28 weeks' gestation every 4 w
 - 28-36 weeks every 2 w
 - After 36 every week Thereafter
- For high-risk cases, more frequent visits are needed

- ❖ Initial (booking) visit:

- **Time:** as early as possible during the first trimester.

- It should include:

- 1- History:

- Personal history
- Complaint in detail
- Menstrual history first day of the last normal menstrual period (LNMP)
 - ❖ Inaccurate date: when first day of last menstrual period (LMP) is not known for sure,
 - ❖ Unreliable date: a date that is known but cannot be used for assessment of the expected date of delivery (EDD). e.g.
 - Women with irregular cycles before conception,
 - Women who got pregnant during lactational amenorrhea,
 - Women who were using coc in three m before conception.

- Obstetric history

- Number, mode of termination & outcome of previous pregnancies
- Number & sex of living children
- Date of last labor & last abortion

- History of the currant pregnancy
 - Pregnancy symptoms
 - Warning symptoms
- Family history:
 - Diabetes mellitus (DM) & hypertension
 - Multiple pregnancy & congenital anomalies
- Medical history:
 - Medical disease e.g. DM, hypertension & heart disease
 - Drugs allergy o Blood transfusion
 - X-ray exposure
- Surgical history

2. Examination:

- General
 - Vital signs
 - Weight & height
 - Gait
 - Abnormal color: pallor or jaundice,
 - Head & neck examination
 - Thyroid examination
 - Chest & heart examination
 - Breast examination
 - Back examination
 - Lower limb
 - Skeletal or neurological abnormalities
- Abdominal
 - Tenderness, rigidity or any palpable organs
 - Fundal level (FL)
 - Fundal grip
 - Umbilical grip
 - First & second pelvic grips
 - Auscultation: Fetal heart sounds (FHS)
 - ✓ From 10-12 weeks, use the hand held Doppler
 - ✓ From 20 - 24 weeks, use the Pinard fetal stethoscope

3. Investigations:

- Laboratory investigations:
 - CBC, ABO grouping & Rh type
 - Screening for diabetes
 - Urine analysis & culture
- Pelvic ultrasound: RCOG recommends ultrasound as early as possible for confirmation of ongoing pregnancy & accurate estimation of the gestational age

Spotlight In Obstetrics

❖ Periodic (return) visits : Provide continuous health education

- It should include:

1-History: For new complaints & warning symptom

2-Examination

- Weight, blood pressure & edema of lower limbs
- FL & FHS
- At 37 week
 - Assessment of fetal size, lie, & presentation
 - Assessment of pelvic capacity

3-Investigations:

- Laboratory investigations:
 - Screening for gestational diabetes at 24 -28 weeks of pregnancy
 - Urine exam by dipstick for protein, glucose & ketone
- Pelvic ultrasound: RCOG recommend ultrasound between 18-22 weeks to diagnose or exclude congenital fetal anomalies

✓ **NB:** Assessment of fetal well-being in a low-risk pregnancy

- **Fetal size:** assessment of the FL or the symphyseal-fundal height.
- **Daily fetal movement count (DFMC):** at least 10 movements /12 hours

Health education for pregnant women:

➤ Adequate nutrition

• <u>Calories</u> <u>(2500 cal/day)</u>	<ul style="list-style-type: none"> ▪ Calories excess lead to fat deposition & obesity. ▪ Calories requirement in the first trimester is the same as in the non-pregnant state & increase in the second & third trimester.
• <u>Protein</u> <u>(60 gm/day)</u>	<ul style="list-style-type: none"> ▪ Animal sources: meat, fish, cheese, milk & eggs ▪ Plant sources: peas, beans & lentils ▪ Marked protein insufficiency in diet leads to fetal prematurity & intrauterine growth restriction maternal anemia & edema
• <u>Calcium</u> <u>(1.2 gm/day)</u>	<ul style="list-style-type: none"> ▪ Sources: milk, cheese, yogurt & calcium carbonate ▪ Insufficient Ca^{+2} → rickets in infants & osteomalacia in mothers
• <u>Iron</u> <u>(30 — 60 mg of elemental iron/day)</u>	<ul style="list-style-type: none"> ▪ Animal sources: liver & red meat ▪ Plant source: dark green vegetables ▪ Drug sources: ferrous gluconate, ferrous fumarate & ferrous sulfate ▪ Dose of 30 - 60 mg elemental iron/day is enough for most women obese women can take 60-100 mg/day. ▪ Insufficient iron in diet leads to maternal iron deficiency anemia.

Spotlight In Obstetrics

• Fats:

- If 2/3 of proteins are taken from animal sources, the intake of fats will be adequate.
- (400 ug/day) is recommended during 1st trimester to reduce incidence of neural tube defect e.g. anencephaly & spina bifida.
- Women with personal or family history of neural tube defects 4-5 mg of folic acid/day is recommended three months prior to conception & during 1st trimester.

➤ **Clothing:**

- Clothing should be loose & avoid high heels

➤ **Dental care**

- Have teeth examined twice during pregnancy,
- Brush teeth after meals.
- Tooth extraction is allowed even for pregnant women with rheumatic heart disease if prophylactic antibiotics are given.

➤ **Breast care**

- Wash daily to reduce cracking,
- Massage
- Nipples:
 - If there is dry secretion, treat with a mixture of glycerin & alcohol.
 - If retracted, treat by pulling out gently & regularly.

➤ **Sexual activity**

- Allowed in moderation.
- Avoided in pregnant women with threatened abortion, preterm labor, or antepartum hemorrhage (APH).

➤ **Travel**

- Allowed when comfortable.
- Those traveling more than three hours (either by car or airplane) must take a break every two hours & walk for about five minutes to decrease the risk of deep vein thrombosis.

➤ **Weight gain**

- Most of the weight gain occurs in the second trimester,
- Normal weight women should gain 11.5-15 kg.
- Underweight women should gain 12.5-18 kg.
- Obese women should gain no more than 7 kg.

➤ **Baths**

- Showers are preferable over tube baths to avoid falling,
- Vaginal douches are not allowed.

➤ Exercise & work

- Exercise should be mild, preferably walking,
- Housework, if not overtiring, is allowed.

➤ Sleep & rest

- Sleep eight hours at night & rest two hours in the afternoon,
- Increase amount of sleep & rest toward term.

➤ Smoking associated with increased risk of:

- Abortion o Ectopic pregnancy
- Molar pregnancy
- APH (placental abruption & placenta previa)
- Fetal anoxia o IUGR
- Premature rupture of the membranes (PROM)
- Preterm labor
- Prematurity & its complications
- Low birth weight neonates (LBW)

➤ Drugs: Avoid all unnecessary drugs during pregnancy.**➤ Immunization**

- Live attenuated vaccines are contraindicated e.g. MMR.
- Any woman comes in contact with rubella should be tested for rubella antibodies.
- Tetanus toxoid to prevent tetanus during each pregnancy should be administrated irrespective of previous administration.

➤ Irradiation:

- Avoid exposure to irradiation for its teratogenic effect on the fetus.

Common complaints during pregnancy

1. Morning sickness (emesis gravidarum)

- Nausea & sometimes vomiting especially in the morning, not affect general condition of the pregnant women,
- Occurs in about 50% of pregnant women (the most frequent complaint of early pregnancy)
- Usually appear at the 6th week & disappears after the 12th — 14th week
- **Treatment:**
 - Reassurance & explanation
 - Small frequent meals (light 3 meals with snacks inbetween)
 - Increase carbohydrate content & decrease fat content
 - Drugs: Antihistaminics, antiemetics & Vit. B6 (Pyridoxine)

2. Heart burn:

- Due to regurgitation of stomach contents into esophagus caused by
- hypotonia of cardiac sphincter (progesterone H & relaxin H effect)
- increase abdominal pressure
- **Treatment:**
 - Small frequent meals (light 3 meals with snacks inbetween)
 - Avoid spicy & fatty foods
 - Avoid lying flat for some time after eating
 - If the above fails, antacids can be tried.

3. Ptyalism:

- Ptyalism may be caused by strange dietary habits, e.g. eating starch.
- If this is found to be case, discuss modification of dietary habits with the woman.

4. Constipation

- Due to pressure of uterus on pelvic colon & progesterone relaxing effect
- **Treatment:**

<ul style="list-style-type: none"> ▪ Bowel training ▪ Minimize coffee & tea ▪ Increase physical activity 	<ul style="list-style-type: none"> ▪ Milk & increase fluid intake ▪ Diet rich in fibers ▪ mild laxative
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5. Hemorrhoids (Piles):

- Effective prevention of constipation may reduce hemorrhoids
- Local agents may be used when indicated.
- Reassure women that hemorrhoids usually disappear after delivery.

6. Leg varicose veins:

- Affects 10-20% of pregnant women
- **Treatment:**
 - Avoid long periods of standing and
 - Avoid constricting clothes
 - Keep the legs elevated while sitting
 - Use of elastic stocking

7. Leg edema:

- Affects 80% of pregnant women,
- Leg elevation may help.

8. Leg cramps:

- Painful spasms of the calf muscles.
- Occur in 50% of pregnant women particularly in the latter half of pregnancy,
- **Treatment:**
 - Magnesium & Calcium supplementation,
 - Massaging & stretching the muscle during the attack.

9. Leucorrhea:

- An increase in the normal vaginal discharge, which is common during pregnancy
- pathological discharge must be excluded
- presence of an abnormal color, odor, or itching may indicate an infectious etiology

Alarming symptoms

1. Vaginal bleeding
2. Escape of fluid from the vagina
3. Decrease or cessation of fetal movements
4. Severe headache
5. Blurred vision
6. Persistent vomiting
7. Abdominal pain specially epigastric & labor pain
8. Swelling of the lower limbs, face or fingers
9. fever